



Treatment of traumatic posterior sternoclavicular dislocations

Gordon I. Groh, MD^{a,*}, Michael A. Wirth, MD^b, Charles A. Rockwood Jr., MD^b

^aBlue Ridge Bone and Joint Clinic, Asheville, NC, USA

^bDepartment of Orthopaedics, University of Texas at San Antonio Health Science Center, San Antonio, TX, USA

Background: Traumatic posterior sternoclavicular joint injuries are rare, but complications are common and include brachial plexus and vascular injury, esophageal rupture, and death.

Materials and methods: The records of 21 patients treated at our institution for a posterior sternoclavicular injury were reviewed. All patients underwent a trial of closed reduction, which was effective in 8 patients (group I). The remaining 13 patients were treated with open reduction and sternoclavicular joint reconstruction (group II).

Results: Closed reduction was more likely to be successful ($P < .05$) in dislocations treated within 10 days of injury. Patients were evaluated by use of the University of California, Los Angeles rating scale. Overall, 18 of 21 patients were graded as good or excellent. Patients treated with either open or closed reduction as their definitive management compared favorably in terms of ratings for pain, strength, and motion.

Conclusion: Our experience suggests that closed reduction compares favorably with open reduction. Of patients treated, 38% required only closed reduction as their definitive treatment. In this series early closed reduction was successful and obviated the risks of surgery. Patients who in whom closed reduction failed obtained good results with operative treatment aimed at reconstruction of the costoclavicular ligaments.

Level of evidence: Level IV, Case Series, Treatment Study.

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Keywords: Posterior sternoclavicular injury; trauma; closed reduction; open reduction; sternoclavicular reconstruction; hilar decompression

Sternoclavicular joint injuries have been classified based on anatomy and etiology, with traumatic posterior dislocation and posteriorly displaced physal fracture of the medial clavicle being the least common types of injuries.^{7,33-35} The serious complications that occur with sternoclavicular joint trauma are primarily limited to those posterior injuries and include brachial plexus compression,^{19,23} pneumothorax

and respiratory distress,^{12,27,29,30} vascular compromise,^{14,18,24,29,30} dysphagia and hoarseness,^{1,12,20,25,26} and death.^{17,20,42} Worman and Leagus,⁴⁹ in a review of the complications associated with posterior sternoclavicular joint injuries, reported that 16 of 60 patients reviewed from the literature had had complications of the trachea, esophagus, or great vessels. Although the majority of these complications are observed at the time of injury, late-appearing complications have also been noted with unreduced retrosternal injuries and include thoracic outlet syndrome and brachial plexopathy,^{13,32} subclavian artery

*Reprint requests: Gordon I. Groh, MD, Blue Ridge Bone and Joint Clinic, 129 McDowell St, Asheville, NC 28801.

E-mail address: ggroh@brbj.com (G.I. Groh).

Table I Patients treated with closed reduction

Patient No.	Age (y)	Sex	Shoulder	Mechanism	Time from injury to reduction (d)	Forward flexion (°)	Follow-up (y)	Function	Pain	UCLA score
1	25	M	L	MVA	0	170	3	NL	OCC	33
2	54	M	R	MVA	0	150	4	SL	OCC NSAIDs	29
3	28	M	L	Fall	1	160	8	NL	OCC	33
4	45	F	L	MVA	0	145	5	NL	OCC NSAIDs	31
5	40	M	R	MVA	0	160	7	SL	OCC NSAIDs	28
6	53	F	L	MVA	0	160	9	SL	OCC	31
7	41	M	R	Fall	10	145	3	SL	OCC NSAIDs	28
8	28	M	L	MVA	0	170	3	NL	None	35

UCLA, University of California, Los Angeles; MVA, motor vehicle accident; NL, normal; SL, slight restrictions only when limb is being used above shoulder level; OCC, occasional; OCC NSAIDs, occasional use of nonsteroidal anti-inflammatory drugs (salicylates).

compression,² exertional dyspnea,⁴⁸ and fatal sepsis after the development of a tracheoesophageal fistula.⁴²

The serious nature of these injuries and the frequency of associated complications emphasize the importance of careful evaluation and management. The purpose of our report is to review the results of treatment in 2 groups of patients with traumatic posterior sternoclavicular joint injuries. The first group of patients (group I) was treated with closed reduction as their definitive management. In group II closed reduction failed, and these patients were managed with open reduction and reconstruction of the costoclavicular ligaments.

Materials and methods

Institutional review board approval was received from the San Antonio Health Science Center of the University of Texas (study No. HSC20080269H).

Between 1976 and 2003, 34 patients with a traumatic posterior sternoclavicular joint injury were treated by the 2 senior authors at our institution. Eight of these patients were diagnosed with a displaced physal fracture of the medial clavicle and excluded. Of the remaining 26 patients, 1 died and 4 were lost to follow-up, leaving 21 available for evaluation. The medical records of the 21 patients were examined and reviewed and served as the basis of this report. There were 17 men and 4 women. The mean age at the time of treatment was 30 years (range, 24-54 years). The patients were divided into 2 groups based on whether they had received closed reduction or open reduction as their definitive treatment.

Group I (closed reduction)

Group I consisted of 8 patients, 6 men and 2 women, with a mean age of 39 years (range, 25-54 years). The injuries involved 5 left shoulders and 3 right shoulders. Of the shoulders, 6 were injured in motor vehicle accidents and 2 in falls from a height (Table I).

Signs and symptoms related to the injury were numerous and included ipsilateral upper extremity cyanosis and swelling, weakness, and subjective numbness or tingling (5 patients); dyspnea (2 patients); and dysphagia (1 patient) (Figure 1). All patients had marked pain in the region of the sternoclavicular

joint. In 3 patients, the pain was exacerbated by lying supine or in the lateral decubitus position. Injuries were isolated to the sternoclavicular joint in 6 patients. The remaining 2 patients had a number of associated injuries, including facial fracture, vertebral and extremity fractures, and pulmonary as well as cardiac contusion.

Treatment consisted of closed reduction via an abduction traction technique.^{4,35,36} The reduction was performed on the day of injury in 6 patients, 1 day after injury in 1 patient, and 10 days after injury in 1 patient. The abduction traction method of reduction is performed by placing the patient in the supine position with the dislocated shoulder near the edge of the table with a sandbag 3 to 4 inches thick between the shoulders. Lateral traction is applied to the abducted arm, which is then gradually brought back into extension. It is important to emphasize that traction always preceded extension of the arm to prevent the anterior aspect of the medial clavicle from binding on the posterior surface of the manubrium. When this technique was unsuccessful in 2 patients, the skin over the medial clavicle was prepared and draped in surgical fashion and a sterile towel clip was used to facilitate the reduction by encircling the medial clavicle and applying lateral and anterior traction. Intraoperative radiographs were assessed for reduction of the dislocation. A serendipity view was used for assessment.³⁵ This radiograph is obtained by tilting the x-ray tube 40° cephalic and is aimed directly at the manubrium. Reduction of the posterior sternoclavicular joint injury was confirmed by computed tomography. Closed reduction in the operating room was performed without the need to require a thoracic surgeon to be available.

Group II (operative treatment)

Group II consisted of 13 patients, 11 men and 2 women, who had a mean age of 36 years (range, 24-45 years). Ten right shoulders and three left shoulders were injured. Of the shoulders, 8 were injured in motor vehicle accidents, 2 shoulders in sporting events (rodeo), 2 shoulders in a fall, and 1 when a horse crushed the patient (Table II).

All patients had pain in the region of the sternoclavicular joint. In 3 patients, the pain was exacerbated by lying supine or in the lateral decubitus position. Signs and symptoms included shortness of breath or dyspnea on exertion (7 patients); dysphagia or a choking sensation (4 patients); ipsilateral upper extremity cyanosis and swelling, weakness, and subjective numbness or

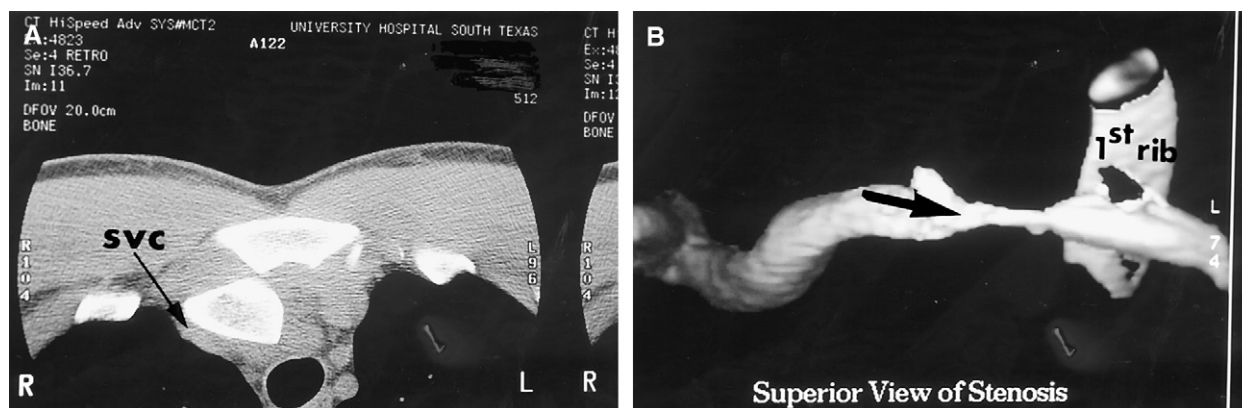


Figure 1 (A, B) Computed tomography scans showing posterior displacement of right medial clavicle with compression of superior vena cava (arrow). Presenting signs and symptoms included ipsilateral upper extremity swelling and dysphagia.

Table II Patients treated with open reduction

Patient No.	Age (y)	Sex	Shoulder	Mechanism	Time from injury to reduction	Forward flexion (°)	Follow-up (y)	Function	Pain	UCLA score
1	28	M	L	MVA	1 d	145	3	NL	OCC	31
2	24	M	R	Rodeo	1 wk	170	3	NL	None	35
3	33	M	R	MVA	7 mo	150	4	NL	OCC NSAIDs	31
4	43	F	R	Fall	2 mo	160	5	NL	OCC	33
5	29	M	R	MVA	4 mo	145	4	SL	OCC NSAIDs	31
6	31	M	R	Rodeo	7 mo	170	3	NL	None	35
7	47	M	R	MVA	1 d	155	3	SL	OCC NSAIDs	31
8	51	M	R	Horse	9 mo	150	3	NL	None	33
9	30	M	L	MVA	3 wk	165	12	SL	OCC NSAIDs	31
10	55	F	R	Fall	18 mo	145	4	SL	OCC NSAIDs	27
11	31	M	R	MVA	11 mo	150	8	SL	OCC	31
12	39	M	L	MVA	4 mo	160	5	NL	None	33
13	27	M	R	MVA	3 mo	155	7	SL	OCC NSAIDs	28

UCLA, University of California, Los Angeles; MVA, motor vehicle accident; NL, normal; SL, slight restrictions only when limb is being used above shoulder level; OCC, occasional; OCC NSAIDs, occasional use of nonsteroidal anti-inflammatory drugs (salicylates).

tingling (4 patients); and a dysphoric sensation associated with tachycardia and diaphoresis while performing manual labor (1 patient). Associated injuries included multiple rib fractures and pneumothorax (4 patients); pulmonary contusion (3 patients); and cardiac contusion, facial fractures, subclavian artery pseudoaneurysm, and subclavian vein stenosis (1 patient). The indications for surgery were failed closed reduction (1 patient), recurrent posterior sternoclavicular dislocation (3 patients), and remaining or progressive symptoms attributed to the posteriorly displaced medial clavicle (9 patients). Nine patients showed fixed posterior displacement of the medial clavicle because of scarring and soft-tissue contracture that we related to the chronicity of the displacement. Three patients had recurrent posterior sternoclavicular dislocation with forward elevation of the ipsilateral upper extremity. The posterior displacement of the medial clavicle was associated with dyspnea and would spontaneously reduce when the arm was adducted to the patient's side while the shoulders were simultaneously retracted. The final patient showed post-reduction instability, which could not be maintained with bracing.

The operations were performed at a mean of 5 months after injury (range, 1 day to 18 months). At the time of surgery, the

mediastinal space was decompressed by medial clavicle excision. An integral component of the procedure was stabilization of the clavicle to the first rib by repair or reconstruction of the costoclavicular joint. A thoracic surgeon was available during reconstruction in each case.

Operative technique

The patient is positioned supine on the operating table with 3 or 4 towels or a sandbag between the scapulae.^{36,37} The skin incision parallels the superior border of the medial clavicle and extends over to the notch of the manubrium and down over the anterior surface of the manubrium. The periosteum of the clavicle is incised in line with the skin incision and preserved for later closure (Figure 2). The clavicular head of the sternocleidomastoid muscle and the clavicular origin of the pectoralis major muscle are reflected subperiosteally to facilitate exposure of the sternoclavicular joint. In a true sternoclavicular dislocation with disruption of the costoclavicular ligament, the medial 1.5 to 2.0 cm of the clavicle is resected, with care taken not to damage the vascular structures that are posterior to the medial clavicle and

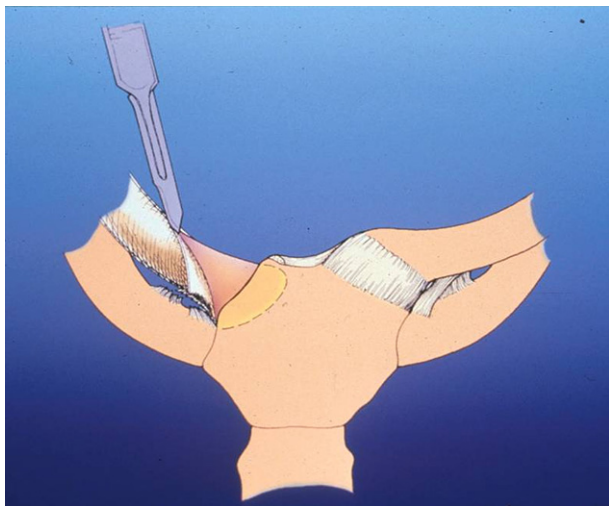


Figure 2 Subperiosteal exposure of medial clavicle.

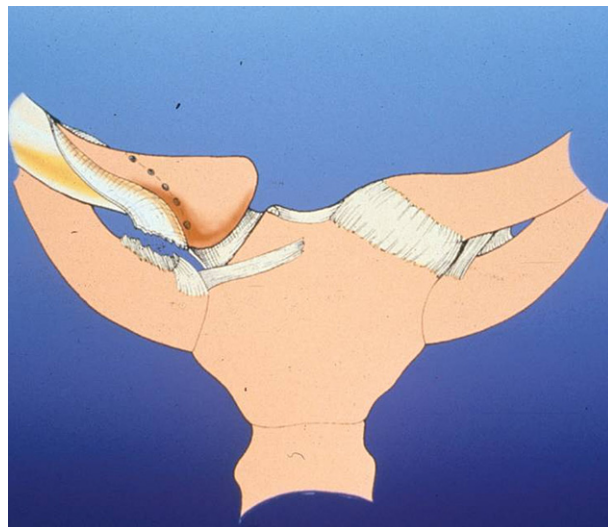


Figure 3 An air drill with a side-cutting bur is used to perform the resection. Adequate protection of the vital structures that lie posterior to the medial end of the clavicle is required.

sternoclavicular joint (Figure 3). This resection is performed by placing a curved Crego retractor or a small ribbon retractor behind the clavicle at the intended osteotomy site. After the medial clavicle has been resected, 3 or 4 pieces of 1-mm Cottony Dacron sutures (Deknatel, Fall River, MA) are passed around the remaining medial end of the clavicle and its periosteal tube and then through the residual costoclavicular ligament and periosteum on the dorsal surface on the first rib to stabilize the medial clavicle (Figure 4). In the shoulders in this series, the costoclavicular ligaments were found to be intact on the periosteal sleeve, and repair of the periosteum reapproximated the ligaments to the medial clavicle. After closure of the periosteum, the sternoclavicular joint can be further stabilized with several nonabsorbable sutures, which are passed around the medial clavicle and secured to the remaining intact costoclavicular ligament.³⁷

Postoperative management

Postoperatively, the shoulders were held in a position of scapular retraction for 6 to 8 weeks with a figure-of-8 dressing or a commercially available clavicle strap. The patients were allowed to perform gentle pendulum exercises but were cautioned against active flexion or abduction of the shoulder above 90°. Forceful pushing, pulling, and lifting were avoided for 3 months. Beginning at 12 weeks, patients were instructed on a physician-directed rehabilitation program of stretching and strengthening exercises.⁴⁸

Results

The mean length of follow-up was 5 years (range, 2-16 years). Results were evaluated with respect to pain, function, range of motion, strength, and patient satisfaction according to the University of California, Los Angeles rating scale. Overall, 18 of 21 patients were graded as good or excellent with considerable improvement in the ratings for pain, strength, and motion, as well as the ability to carry out daily work and sports activities.

Group I

Closed reduction resulted in definitive management for group I. Closed reduction was more likely to be successful ($P < .05$) if undertaken within 10 days of injury. The shoulder scores group I patients ranged from 29 to 35 points (mean, 31 points). Of the 8 shoulders, 3 had an excellent result and 4 had a good result. Occasional, mild pain was noted in 4 patients. In 1 patient, this was associated with a subtle click or catching sensation localized to the sternoclavicular joint. Another patient described mild discomfort in the sternoclavicular joint during abrupt deceleration in a motor vehicle. This was an isolated incident, and the transient discomfort was attributed to pressure from the shoulder strap of the safety restraints. One patient noted pain with golf, and this was controlled with intermittent use of nonsteroidal anti-inflammatory medication.

All 8 patients were able to use the involved limb above shoulder level for activities of daily living, work, and sports. Four patients reported normal function with all activities, whereas four patients noted a slight restriction. All patients showed more than 150° of active elevation and were satisfied with the results of treatment.

Group II

An excellent result was achieved in 5 of the 13 operatively treated shoulders, a good result in 6, and a fair result in 2. The shoulder scores for group I patients ranged from 27 to 35 points (mean, 32 points). Occasional or no pain was present in 11 shoulders. Mild pain with overhead use of the arm or bench-press weight lifting was noted in 2 patients. All patients had more than 150° of active elevation. Seven patients reported normal function with all activities of daily

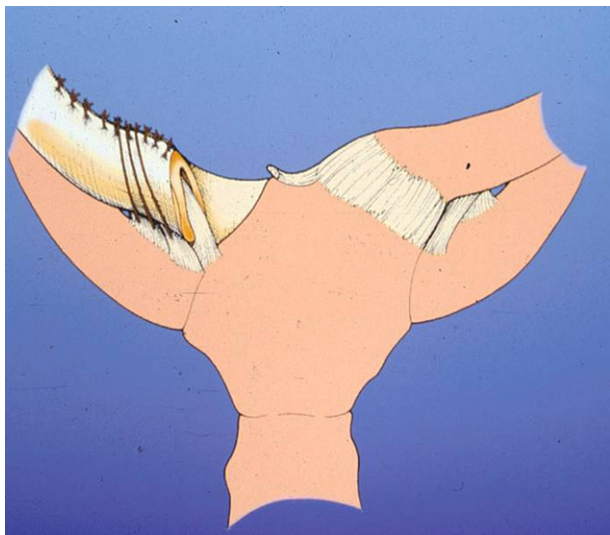


Figure 4 Closure of periosteal sleeve around medial clavicle and secure fixation of these structures to costoclavicular ligament and first rib.

living, work, and sports. Six of these patients were involved in heavy manual labor, which included working in feed lots, saddle riding, bucking hay, and breaking horses. The seventh was a real estate appraiser. Three patients had slight restriction while using the involved limb above shoulder level for various sport or work activities. Three patients had more than slight restriction when using the limb above shoulder level but were unrestricted when the limb was used below the level of the shoulder. Two patients reported no change in work. The remaining patient was a heavy equipment operator and carpenter who changed his vocation to minimize overhead activity, which was associated with occasional discomfort.

Discussion

The complications associated with an unreduced posterior sternoclavicular dislocation are numerous and include thoracic outlet syndrome with swelling and cyanosis of the upper extremity,^{13,31,50} vascular compromise,^{1,13,14,18,49} brachial plexus injury,^{4,28,39} and fatal tracheoesophageal fistula.⁴³ Buckerfield and Castle⁴ reported successful closed reduction of a traumatic posterior sternoclavicular dislocation or posterior physeal fracture-dislocation in 6 of 7 patients ranging in age from 13 to 26 years. In their patients, reduction was achieved by retraction of the shoulders with caudal traction on the adducted arm while an interscapular bolster supported the patient. Closed reduction was accomplished within 24 hours after injury in 6 patients and at 96 hours after injury in 1 patient. One patient showed postreduction instability, but the reduction was maintained by holding the shoulders in full retraction with a figure-of-8 clavicular strap. Two of their patients

were lost to follow-up, and the remaining five had full range of motion without pain, discomfort, or deformity at a mean follow-up of 10 months. Lafosse et al²¹ recently reported their experience with posterior sternoclavicular injuries and showed success in one half of the cases treated with closed reduction. Our experience with early closed reduction was similar, in that 7 patients underwent reduction within 24 hours of injury and 1 patient underwent reduction 10 days after injury. The fact that one of the injuries in our series underwent reduction 10 days after injury suggests that closed reduction may be successful even after 10 days.

Several authors have recommended open reduction when closed reduction has failed, because of the potential problems that can be associated with posterior displacement of the medial clavicle into the mediastinum.^{2,35,36,40,44-47} In our series, operative management consisted of decompression of the mediastinum by excision of the medial clavicle. The residual clavicle was then stabilized to the costoclavicular ligament and the periosteum of the first rib.

In 1967, Denham and Dingley⁷ reported 3 cases of medial clavicle physeal injury in patients aged 14 to 16 years. They showed at surgery that the pathology was indeed a physeal fracture of the medial clavicle. This is important information to remember because many so-called dislocations of the sternoclavicular joint are not dislocations but are physeal injuries, because the medial clavicular epiphysis does not close until the 23rd to 25th year.^{5,16,17,32,35}

Various authors have recommended open reduction—internal fixation for acute injuries, as well as for chronic problems.^{8-11,31,49} Although we agree that unreduced acute or chronic posterior sternoclavicular dislocations should be managed operatively, we believe that the placement of pins across the sternoclavicular joint is contraindicated because of the many serious complications that can occur with this technique. We are aware of 7 deaths^{6,15,22,28,38,41} and 3 near deaths^{3,29,44} from complications of transfixing the sternoclavicular joint with Kirschner wires or Steinmann pins. The pins, either intact or broken, migrated into the heart, pulmonary artery, innominate artery, or aorta. In 1990, Lyons and Rockwood²³ reviewed the literature regarding the migration of pins and similar devices that were used in operations on the sternoclavicular joint. The number of patients who needed a thoracotomy, sternotomy, vascular repair, laminectomy, or laparotomy confirmed the seriousness of migration of pins from the sternoclavicular joint. The authors concluded that the risk of migration after fixation of the sternoclavicular joint with pins was sufficiently great and grave so as to absolutely contraindicate their use in surgical procedures on this joint.

We observed no incidences of instability using our reconstruction technique^{36,37} repairing the costoclavicular ligaments. Although other biomechanical studies have shown initial improved stability using a figure-of-8 tendon reconstruction technique,⁴² we are not aware of any clinical studies reporting improved outcomes. Reconstruction of the

costoclavicular ligament with local tissue further obviates the need for a graft harvest or utilization of allograft material. We advocate use of additional reconstructive techniques⁴² if local tissues are deemed inadequate for stable reconstruction.

Conclusion

Patients in both groups compared favorably in terms of improvement in ratings for pain, strength, motion, and the ability to perform work and sports. Early recognition of the injury seems to improve the probability that closed reduction will be successful. Moreover, once the joint has been reduced closed, it is usually stable. In this series, early recognition of injury followed by closed reduction and figure-of-8 immobilization was highly successful, obviated the risks of surgery, and resulted in an outcome that compared favorably with that of operative treatment. When closed reduction fails, open reduction combined with reconstruction of the costoclavicular ligaments results in a stable construct.

Disclaimer

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